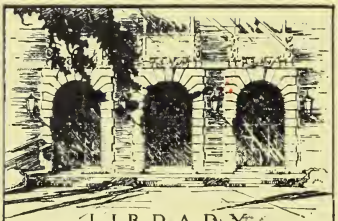

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Lightplane Tires On Turf and Concrete

By

Leslie A. Bryan

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UNIVERSITY OF ILLINOIS
THE INSTITUTE OF AVIATION

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Lightplane Tires On Turf and Concrete

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FOREWORD

THIS MONOGRAPH is the sixth in a series of bulletins on aviation subjects which are being issued from time to time by the Institute of Aviation. The study was undertaken as a result of a staff discussion with Dr. John Monteith, Jr., an acknowledged airport turf authority, while planning flight-training activities at the University of Illinois Airport.

Although those present agreed that turf runways are easier than concrete runways on aircraft tires, surprisingly, no records or even estimates of the amount of wear and tear caused by either type of runway could be found. Consequently, the Institute decided to keep records of the tires used on some of the aircraft in its flight-training program in order that an appraisal of the actual difference in tire wear on concrete and on turf at this Airport, at least, might be made. The results are herewith made available.

Since the experiment was an adjunct to a full program of other activities, the cooperation of Mr. Jesse W. Stonecipher, Chief Flight Instructor; Mr. Arthur E. Beachler and Mr. Forest Lancaster, Aircraft Maintenance Engineers; and Miss Bernice Schrader, Editor, as well as their respective staffs, all of the Institute of Aviation, is gratefully acknowledged.

In this monograph, as in all publications of the Institute, the author has had complete freedom to express his opinions, understanding that he assumes sole responsibility therefor.

Leslie A. Bryan
Director

June, 1949

INTRODUCTION

It is generally assumed that turf runways cause less wear and tear on lightplane tires and undercarriages than do hard-surfaced runways. To test the validity of this assumption an experiment was carried on at the University of Illinois Airport from June 20, 1947, until November 1, 1947. The experiment was projected as an adjunct to the regular student flight instruction program conducted by the Institute of Aviation. Its aim was to determine the comparative effects of concrete runways and turf runways on the tires and the landing gears of lightplanes used in routine flight-training operations and to see if these effects could be measured. The details and results of this experiment are given in the first part of this report.

On November 1, the turf-runway airplanes were transferred to the concrete because turf landings are discontinued at this Airport as soon as the ground has frozen. Such transfer helps to prevent peeling of the sod and to keep the turf in the best possible condition for warm weather use. The study of the two groups of airplanes was continued from November 1 until March 15, 1948, even though both were using concrete runways, in order to note the effects of cold weather on the tires. The details and results of this aspect of the study are given in the second part of the report.

It is not claimed that the results are relevant to all situations. Exact scientific control was impossible since the operating conditions were actual, not simulated, and some human element was involved. For that very reason, however, the results may be more valuable. While the conclusions reached may not be universally applicable, it is believed that they portray the facts pertinent to the local situation and, consequently, possess some validity for generalization. Certainly this experiment, as far as can be determined, represents the first attempt to measure the actual wear and tear caused by concrete and turf runways on tires and undercarriages of lightplanes under actual operating conditions.

CONCRETE RUNWAYS VERSUS TURF RUNWAYS

Method and Procedure

At the University of Illinois Airport on June 20, 1947, ten Aeronca Champion airplanes were divided into two groups of five and equipped with new 6.00 x 6 All-Weather Tread Goodyear tires. The average weight of these tires was 8.03 pounds. The airplanes, which were comparable in age and in flight-hours, were then returned to the flight line for ordinary activity as student trainers in the Institute of Aviation's flight instruction program.

A daily record, indicating the number of tire and airplane hours in the air and the number of tire and airplane landings, as well as the frequency of tire changes and the condition of discarded tires, was kept for each airplane throughout the entire thirty-eight-week period. Tire inflation was maintained at approximately eighteen pounds. For the sake of accuracy in the final results, a separate tabulation was made of the number of *tire* flight-hours and *tire* landings, as distinguished from *airplane* flight-hours and *airplane* landings. Flight-hours are computed from the time the throttle is opened for the take-off until the throttle is cut on return to the flight line. In addition, the aircraft inspections made to determine whether or not there was any unusual wear on the undercarriages of the airplanes were recorded.

Until November 1, the airplanes in one group were landed only on the concrete runways which at the University of Illinois Airport are composed of cement and an aggregate of torpedo sand and gravel, or crushed rock, completed in a belt-finish. Those in the other group were landed only on the well-kept turf bed, which had been seeded from a mixture of perennial rye grass, white and alsike clover, and Kentucky bluegrass.

The Period June 20-August 7

Thirty-one days after the experiment began, three tire changes in the concrete-runway group were recorded. On July 21, Airplane No. One needed two replacements because fabric was showing on both of its month-old tires. Each of these discarded tires had made 565 landings and had had 129 flight-hours.

Later the same day, one new tire was put on Airplane No. Two. This discarded tire had had 126 flight-hours, but it had made only 400 landings. Eight days later, on July 29, both tires were renewed on Airplane No. Three after 596 landings and 177.2 flight-hours per tire.

By August 7, Airplane No. Four and Airplane No. Five also required new tires, the originals having been worn to the fabric — those on Airplane No. Four after 492 landings and 182.1 flight-hours per tire, and those on Airplane No. Five after 611 landings and 171.9 flight-hours per tire.

Thus, after only forty-eight days, the concrete-runway group of five airplanes had required nine tire replacements. Just one original tire was still being used. The total number of landings made by these

TABLE 1. CONCRETE-RUNWAY GROUP
(June 20-August 7)

Date of Replacement	Airplane	Original Tires	No. of Tire Flight-Hours	No. of Tire Landings
7/21	1	1	129	565
7/21		1	129	565
7/21	2	1	126	400
7/29	3	1	177.2	596
7/29		1	177.2	596
8/4	4	1	182.1	492
8/4		1	182.1	492
8/7	5	1	171.9	611
8/7		1	171.9	611
Total		9	1,446.4	4,928

nine tires was 4,928, and their total number of flight-hours was 1,446.4. The five airplanes in the turf-runway group were still using their ten original tires which so far had made a total of 6,568 landings and had had 2,134.4 flight-hours.

Up to this point the airplanes in the concrete-runway group had made a total of 3,037 landings and had had 949.3 flight-hours. The airplanes in the turf-runway group had made a total of 3,284 landings and had had 1,067.2 flight-hours (247 more landings and 117.9 more flight-hours than the five airplanes in the concrete-runway group). The mechanics were unable to detect signs of unusual wear on the undercarriages of any of the airplanes.

The Period August 8-October 31

A month passed during which there were no tire changes. Then, on September 10, the tenth tire of the concrete-runway group was discarded. This original tire, which had worn longer than any of the other nine, had made 826 landings and had had 319.3 flight-hours. It had worn more than twice as long as the other original tire on Airplane No. Two. The first one had been discarded after only 400 landings.

On the same day Airplane No. Four required its second replacements after just 244 landings and 110.2 flight-hours per tire. One of these replacements was discarded on October 23 after only 154 landings and 73.7 flight-hours. During the entire course of the study, this

TABLE 2. CONCRETE-RUNWAY GROUP
(August 8-October 31)

Date of Replacement	Airplane	Number of Replacements	No. of Tire Flight-Hours	No. of Tire Landings
9/10	2	1*	319.3	826
9/10	4	1	110.2	244
9/10		1	110.2	244
9/23	1	1	218.0	453
10/22	3	1	213.8	409
10/23	4	1	73.7	154
Total		6	1,045.2	2,330

* The tenth original tire.

was the minimum number of landings made by any of the tires used. No reason for this deviation from the length of service given by the tires on the other airplanes was apparent.

Airplane No. One, on September 23, and Airplane No. Three, on October 22, required one new tire each — the former after 453 landings and 218 flight-hours, the latter after 409 landings and 213.8 flight-hours.

Thus, within seventy-six days, from August 8 to October 23, six more tires had been discarded in this group of airplanes. These six tires had made a total of 2,330 landings and had had 1,045.2 flight-hours. All of the original tires in the turf-runway group were still in use at the end of this period.

Comments on the Results

Certain variables may have influenced the results. The belt-finished concrete runways at the University Airport, because of their relative newness, may have been unusually rough on tires and, therefore, may have greatly reduced the number of landings per tire in the concrete-runway group. The airplanes in the turf-runway group may have suffered also, since they were taxied and parked on similar concrete even though they took off from and landed on turf only. There may have been some difference in the age of the tires themselves, although all were unused at the time the experiment started.

On the other hand, the excellent condition of the turf at the Airport may have been a factor in the long life of the tires used on it. Unfortunately, it was not possible to determine accurately the useful life of the tires in the turf-runway group, since they were transferred to the concrete on the first of November. Had these airplanes continued to take off from and land on the turf after it had frozen, there might have been some differences in the results.

It is evident that the tires of the airplanes using the concrete runways did not show a consistent amount of wear, although all of the airplanes were used daily in the student training program and subjected to approximately the same conditions. For example, the two original tires on Airplane No. Four made 492 landings each. The set of tires which replaced them made just 244 landings per tire. One of the next set of tires lasted for only 154 landings, while the other tire, as further study revealed, made 499 landings. Also, one tire on Airplane No. Two made only 400 landings, while the other made 826.

Since all of the tires, presumably, were identical when new, and since it is assumed that the length of the take-off run and the landing run would normally be approximately the same, such factors as an excessive use of brakes, the relative skill of the trainees, and an unusual number of crosswind landings might have contributed to the unevenness in the amount of wear.

The discarded tires showed a uniform weight loss of approximately two and one-half pounds per tire, with the exception of the tire which was removed from Airplane No. Two on July 21. It showed the high weight loss of three pounds.

It should be remembered that the above-normal heat during the months of August, September, and October, 1947, undoubtedly had more effect on the temperature of the concrete than on that of the turf. Some indication of the effects of hot concrete versus the effects of cold concrete on tires is given in the second part of this report.

By November 1, the airplanes in the turf-runway group had made a total of 5,378 landings and had been operated for a total of 2,034 flight-hours. The airplanes in the concrete-runway group had made a total of 5,269 landings and had been operated for a total of 1,983.7 flight-hours. Yet the mechanics who had been carefully watching the undercarriages reported that no difference in wear and tear was discernible and that they were unable to tell which aircraft had been used on turf and which on concrete. Their daily inspections were visual only. In addition, they ran the usual 100-hour and annual inspections. During the period of the experiment, they reported no landing gear failures nor any pilot complaints against landing gear action.

Summary

From the statistics gathered during this phase of the experiment, it is apparent that the turf runways caused less wear and tear on the tires of the airplanes than did the concrete runways. Therefore it seems reasonable to conclude that in a period of 133 days at least fifteen tires might have been saved by landing the airplanes of the concrete-runway group on the turf.

Further, at this stage in the experiment, disregarding the wear remaining in the tires used on turf, it appeared that a minimum of 150 per cent more tire usage was possible by making landings and take-offs on turf instead of on concrete.

Finally, no appreciable difference in wear and tear on the landing gears of the airplanes was discernible through conventional inspections regardless of whether the airplanes had been used on the turf or on the concrete landing areas.

EFFECTS OF COLD WEATHER

November 1 Status

On November 1, the turf-runway airplanes were transferred to the concrete runways because the ground had frozen. These airplanes, by this time, had made a total of 5,378 turf landings and had had a total of 2,034 flight-hours. They still wore the ten original tires, which had made a total of 10,756 tire landings and had had 4,068 tire flight-hours.

The five airplanes in the original concrete-runway group had made a total of 5,269 landings (109 less than the other group) and had had a total of 1,983.7 flight-hours (50.3 hours less). Their ten original tires, as well as five others, had been discarded. The ten tires with which they were now equipped had made a total of 3,279 tire landings and had had 1,475.8 tire flight-hours.

Original Turf-Runway Group, November 1-March 15

No tire changes were made on the airplanes in this group until February 2, 1948. On that day one tire on Airplane No. One was discarded after 699 landings on the concrete and 269.3 flight-hours. It had already totaled 1,138 landings on turf and 448.8 flight-hours.

Also, on the same day, one tire on Airplane No. Two was discarded after 559 landings on the concrete and 228.8 flight-hours. It had totaled, in addition, 1,091 turf landings and 390.3 flight-hours.

Within the next twenty-four days, there were four more tire

TABLE 3. TURF-RUNWAY GROUP
(June 20, 1947-March 15, 1948)

Plane	Date of Replacement	Original Tires	Total Tire Flight-Hours	Total Tire Landings	Turf Tire Flight-Hours	Turf Tire Landings	Concrete Tire Flight-Hours	Concrete Tire Landings
1	2/2	1	717.7	1,837	448.4	1,138	269.3	699
2	2/2	1	619.1	1,650	390.3	1,091	228.8	559
3	2/3	1	670.4	1,805	382.2	1,074	288.2	731
	2/3	1	670.4	1,805	382.2	1,074	288.2	731
4	2/7	1	598.8	1,588	390.7	1,035	208.1	553
	2/26	1	618.9	1,635	390.7	1,035	228.2	600
5	3/13	1	703.7	1,761	422.4	1,040	281.3	721
	3/13	1	703.7	1,761	422.4	1,040	281.3	721
Total		8	5,302.7	13,842	3,229.3	8,527	2,073.4	5,315

changes on the airplanes of this group. On February 3, both tires were changed on Airplane No. Three after 731 landings on the concrete and 288.2 flight-hours. These were in addition to the 1,074 turf landings and 382.2 previous flight-hours.

On February 7, one tire on Airplane No. Four was discarded after 553 landings on the concrete and 208.1 flight-hours. The other tire was changed on February 25, after 600 concrete landings and 228.2 flight-hours. Each of these tires had already made 1,035 turf landings and had had 390.7 flight-hours.

The only other replacements were made on March 13, just two days before the study ended. Both tires on Airplane No. Five were discarded after 721 landings on the concrete and 281.3 flight-hours, in addition to the 1,040 turf landings and 422.4 flight-hours made earlier.

Thus, during the cold months, eight of the original tires had made a total of 5,315 landings on the concrete and had had a total of 2,073.4 flight-hours. The other two of the ten original tires were still in use on March 15 — one, on Airplane No. One after 1,138 turf landings and 776 concrete landings, and the other, on Airplane No. Two after 1,091 turf landings and 707 concrete landings.

The total number of tire landings made by the eight tires that wore out was 13,842, and the total number of flight-hours was 5,302.7. Thus, the average number of landings per tire for these eight was 1,730.

The maximum number of landings made by any one tire in the turf-runway group of aircraft was undetermined, since two tires were still in use on March 15, 1948 — one tire on Airplane No. One after 1,914 landings and 760.3 flight-hours, and one on Airplane No. Two after 1,798 landings and 694.2 flight-hours. Of those that wore out, one tire on Airplane No. One had made 1,837 landings and had had 717.7 flight-hours.

The minimum number of landings made by any single tire in the turf-runway group was 1,588. This was a tire on Airplane No. Four which had had 598.8 flight-hours.

As will be shown later, the *minimum* number of landings made by a tire on turf was greater than the *maximum* number of landings made by the best tire on concrete.

The total number of airplane landings made by the airplanes in the turf-runway group during the course of the experiment was 9,025, and the total number of airplane flight-hours was 3,518.9.

Original Concrete-Runway Group, November 1-March 15

During this period the first tire change on an airplane in this group was made on December 9, 1947. One tire on Airplane No. Four was discarded after 499 landings and 184.1 flight-hours. This tire, which was new on September 10, made 193 landings before November 1 and 306 afterwards.

There were no more changes until February 25, 1948, when two tires on Airplane No. Five were discarded after 1,038 landings and 463 flight-hours per tire. Each of these tires, which were new on August 7, made 346 landings before November 1 and 692 afterwards.

One tire on Airplane No. Three was discarded on February 27 after 1,056 landings and 461.4 flight-hours. This tire, which had been in use since July 29, made 491 landings before November 1 and 565 afterwards. The other tire on the same airplane was discarded March 6, after 703 landings and 268.8 flight-hours. It began service on October 22 and made 82 landings before November 1 and 621 afterwards.

The final changes were made on March 13, just two days before the end of the study. Two tires on Airplane No. Two were discarded — one after 1,338 landings and 579.9 flight-hours, and the other after 912 landings and 386.6 flight-hours. The former, which had been in use since July 21, made 648 landings before November 1 and 690 afterwards. The latter, in use since September 10, made 222 landings before November 1 and 690 afterwards.

Thus, in the 136 days between November 1 and March 15, only seven tires in the concrete-runway group wore out. These *seven* tires

TABLE 4. CONCRETE-RUNWAY GROUP

Airplane	Date of Replacement	No. of Replacement	Total Tire Flight-Hours	Total Tire Landings	Before October 31		After November 1	
					Tire Flight-Hours	Tire Landings	Tire Flight-Hours	Tire Landings
4	12/9	1	184.1	499	86.1	193	98.0	306
5	2/25	1	463.0	1,038	167.6	346	295.4	692
	2/25	1	463.0	1,038	167.6	346	295.4	692
3	2/27	1	461.4	1,056	234.4	491	227.0	565
	3/6	1	268.8	703	20.6	82	248.2	621
2	3/13	1	386.6	912	295.7	222	90.9	690
	3/13	1	579.9	1,338	102.4	648	477.5	690
Total		7	2,806.8	6,584	1,074.4	2,328	1,732.4	4,256

had made a total of 4,256 landings on cold concrete and had had a total of 1,732.4 flight-hours in addition to 2,328 landings on concrete and 1,074.4 flight-hours in the warm weather. Their total number of landings on concrete, both before and after November 1, was 6,584, and their flight-hour total was 2,806.8.

The other three tires were still in use on March 15. One of the tires on Airplane No. One had been in service since July 21, and the other tire on the same airplane had been in use since September 23. Before November 1, the former made 682 landings, and the latter made 229. Each of these tires made 584 landings after November 1. On Airplane No. Four, one tire which had been new on October 23 made 40 landings before November 1 and 776 afterwards.

The total number of tire landings made by the twenty-two tires that wore out was 13,842, and the total number of flight-hours was 5,298.4. Thus the average number of landings per tire for these twenty-two was 629.2.

This average may be compared with the average number of landings per tire (1,730) for the eight which wore out after use on both the turf and the concrete.

Since the turf-runway group tires had considerable service on the concrete, and since there were two tires still in use at the end of the experiment, it seems reasonable to conclude that the average tire used on turf can be expected to last for about three times as many landings as the average tire used on concrete.

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The *maximum* number of landings on concrete made by one tire was 1,388. The *minimum* number of landings made by a tire used on both turf and concrete (1,588) was therefore greater than the maximum number made by the best tire used only on concrete. Furthermore, on the concrete runways, one tire lasted for only 154 landings and 73.7 flight-hours. Thus, the *minimum* number of landings for a turf-concrete tire was more than ten times greater than the *minimum* for a tire landed on the concrete.

The total number of airplane landings made by the airplanes in the concrete-runway group during the course of the experiment was 8,796, and the total number of airplane flight-hours was 3,418.7.

Comments on the Results

If the *eight original* tires from the turf-runway group are compared with the *nine original* tires from the concrete-runway group, it can be noted that they, although not new, made more landings on concrete in the cold weather than did the new tires on concrete in the hot weather. To be more specific, the *eight* tires which had already made 8,527 turf landings in hot weather, made 5,315 landings on cold concrete before being discarded, while the *nine* new tires made only 4,928 landings on hot concrete.

If the *seven* tires from the concrete-runway group which wore out after service in both hot and cold weather are compared with the *fifteen* tires from the same group which wore out in hot weather, it can be seen that their total number of landings on concrete (both before and after November 1) was 6,584, and their total flight-hours was 2,806.8. The fifteen new tires used on concrete totaled only 7,258 landings and 2,491.6 flight-hours. Of the fifteen, *nine* totaled only 4,928 landings and 1,446.4 flight-hours, and *six* totaled only 2,330 landings and 1,045.2 flight-hours. Therefore those used on both hot and cold concrete lasted more than twice as long as those used in hot weather only. The experiment does not show how long a tire used only in cold weather would have worn.

Unevenness in wear for the tires in both groups was also evident in this phase of the experiment. In the concrete-runway group, five of the first replacements lasted as follows: One tire on Airplane No. One, new on July 21, 1947, was still in use at the close of the study after 1,266 landings and 542.3 flight-hours; one tire on Airplane No. Two lasted from the same date — July 21 — until March 13, with a total of 1,388 landings and 579.9 flight-hours; one tire on Airplane No. Three, which was new eight days later — July 29 — wore out sooner — February 27 — with a total of 1,056 landings and 461.4 flight-hours; and

TABLE 5. COMPARISON OF CONCRETE AND TURF GROUP AIRPLANES

Concrete Group Airplanes

	Airplane Landings			Airplane Flight-Hours		
Airplane	June 20-October 31	November 1-March 15	Total	June 20-October 31	November 1-March 15	Total
1	1,247	584	1,831	432.5	238.8	671.3
2	1,048	690	1,738	421.7	284.2	705.9
3	1,087	716	1,803	411.6	270.9	682.5
4	930	776	1,706	378.4	313.4	691.8
5	957	761	1,718	339.5	327.7	667.2
Total	5,269	3,527	8,796	1,983.7	1,435.0	3,418.7

Turf Group Airplanes

	Airplane Landings			Airplane Flight-Hours		
Airplane	June 20-October 31	November 1-March 15	Total	June 20-October 31	November 1-March 15	Total
1	1,138	776	1,914	448.4	311.9	760.3
2	1,091	707	1,798	390.3	303.9	694.2
3	1,074	814	1,888	382.2	339.0	721.2
4	1,035	629	1,664	390.7	248.8	639.5
5	1,040	721	1,761	422.4	281.3	703.7
Total	5,378	3,647	9,025	2,034.0	1,484.9	3,518.9

the two tires on Airplane No. Five lasted still a shorter time — from August 7 until February 25 — with 1,038 landings and 463 flight-hours per tire.

In the turf-runway group, two of the original tires were still in use on March 15 — one on Airplane No. One after 1,914 landings and 760.3 flight-hours, and one on Airplane No. Two after 1,798 landings and 694.2 flight-hours.

TABLE 6. MEAN MONTHLY AVERAGE TEMPERATURES
University of Illinois Weather Station, June, 1947-March, 1948*

Date	*Degrees Fahrenheit*	*Variation*
June, 1947	68.6	2.3 *below* normal
July	72.6	3.1 *below* normal
August	80.8	7.4 *above* normal
September	67.8	1.2 *above* normal
October	63.4	8.5 *above* normal
November	37.4	4.1 *below* normal
December	33.3	3.7 *above* normal
January, 1948	22.8	4.0 *below* normal
February	29.8	0.8 *above* normal
March	40.0	0.2 *below* normal

* Illinois State Water Survey Division.

It should be remembered that not only was above-normal heat recorded in this vicinity during the months of August, September, and October, 1947, but also that the winter months of November, January, and March of 1947-48 were colder than normal. As Table 6 indicates, there was a range in the mean monthly average temperatures from a high of 80.8 degrees in August, 1947, to a low of 22.8 degrees in January, 1948. The variations from the normal temperature may have had an appreciable effect on the general results of the experiment.

Since *eight original* tires from the turf-runway group, even though worn, made more landings on concrete in cold weather than did *nine original* tires from the concrete-runway group in hot weather, it is possible to conclude that tires wear at least twice as long on concrete in cold weather as they do in warm weather. This is supported by the fact that the concrete-group showed a better record in the winter than in the summer months. During the cold months only *seven* tires in the concrete-runway group which had had some previous wear on concrete during the warm months wore out as compared with *fifteen* tires in the same group during the hot months.

Final Conclusions

On the basis of the facts gathered in this experiment and subject to the limitations noted, the following conclusions may be drawn:

1. At least a 100 per cent increase in the life expectancy of a tire used on concrete runways can be anticipated during the cooler months of the year.

2. The minimum service given by a tire landed only on turf can be expected to exceed the maximum service which might be obtained from a tire used only on concrete.
3. On turf runways, the average tire will wear approximately three times longer than on concrete runways.
4. Whether the airplane is used on concrete or turf landing areas appears to make no appreciable difference in lightplane undercarriage wear.

TABLE 7. SUMMARY RECORD OF INDIVIDUAL TIRES ON TURF GROUP AIRPLANES

Replacement Date	Plane No. 1		Plane No. 2		Plane No. 3		Plane No. 4		Plane No. 5		Total	
	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings
2/2	717.7	1,837	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2/2	.....	.....	619.1	1,650	.....	.....	.....	.....	.....	.....	.....	.....
2/3	.....	.....	.....	.....	670.4	1,805	.....	.....	.....	.....	.....	.....
2/3	.....	.....	.....	.....	670.4	1,805	.....	.....	.....	.....	.....	.....
2/7	.....	.....	.....	.....	.....	.....	598.8	1,588	.....	.....	.....	.....
2/26	.....	.....	.....	.....	.....	.....	618.9	1,635	.....	.....	.....	.....
3/13	.....	.....	.....	.....	.....	.....	.....	.....	703.7	1,761	.....	.....
3/13	.....	.....	.....	.....	.....	.....	.....	.....	703.7	1,761	.....	.....
Totals of 8 original tires — June 20-March 15											5,302.7	13,842
3/13	760.3	1,914	694.2	1,798	.....	.....	.....	.....	.....	.....	.....	.....
Totals of 2 remaining original tires — June 20-March 15											1,454.5	3,712
2/2	42.6	77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2/2	.....	.....	75.1	148	.....	.....	.....	.....	.....	.....	.....	.....
2/3	.....	.....	.....	.....	50.8	83	.....	.....	.....	.....	.....	.....
2/3	.....	.....	.....	.....	50.8	83	.....	.....	.....	.....	.....	.....
2/7	.....	.....	.....	.....	.....	.....	40.7	76	.....	.....	.....	.....
2/26	.....	.....	.....	.....	.....	.....	20.6	29	.....	.....	.....	.....
3/13	.....	.....	.....	.....	.....	.....	.....	.....	0	0	.....	.....
3/13	.....	.....	.....	.....	.....	.....	.....	.....	0	0	.....	.....
Totals of 6 replacements — June 20-March 15											280.6	496
Grand total of the 16 tires used as of March 15											7,037.8	18,050

TABLE 8. SUMMARY RECORD OF INDIVIDUAL TIRES ON CONCRETE GROUP AIRPLANES

Replacement Date	Plane No. 1		Plane No. 2		Plane No. 3		Plane No. 4		Plane No. 5		Total	
	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings
7/21	129.0	565	126.0	400	.....	.....	.....	.....	.....	.....	....	......
7/21	129.0	565	.....	.....	.....	.....	.....	.....	.....	.....	....	......
7/29	.....	.....	.....	.....	177.2	596	.....	.....	.....	.....	....	......
7/29	.....	.....	.....	.....	177.2	596	.....	.....	.....	.....	....	......
8/4	.....	.....	.....	.....	.....	.....	182.1	492	.....	.....	....	......
8/4	.....	.....	.....	.....	.....	.....	182.1	492	.....	.....	....	......
8/7	.....	.....	.....	.....	.....	.....	.....	.....	171.9	611	....	......
8/7	.....	.....	.....	.....	.....	.....	.....	.....	171.9	611	....	......
Totals of 9 original tires — June 20-August 7											1,446.4	4,928
9/10	.....	.....	319.3	826	.....	.....	110.2	244	.....	.....	....	......
9/10	.....	.....	.....	.....	.....	.....	110.2	244	.....	.....	....	......
9/23	218.0	453	.....	.....	.....	.....	.....	.....	.....	.....	....	......
10/22	.....	.....	.....	.....	213.8	409	.....	.....	.....	.....	....	......
10/23	.....	.....	.....	.....	.....	.....	73.7	154	.....	.....	....	......
Totals of 1 remaining original and 5 replacements — August 8-October 31											1,045.2	2,330

TABLE 8. SUMMARY RECORD OF INDIVIDUAL TIRES ON CONCRETE GROUP AIRPLANES (Concluded)

Re-placement Date	Plane No. 1		Plane No. 2		Plane No. 3		Plane No. 4		Plane No. 5		Total	
	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings	Flight-Hours	No. of Landings
12/9	.....	.....	.....	.....	.....	.....	184.1	499	.....	.....	....	......
2/25	.....	.....	.....	.....	.....	.....	.....	.....	463	1,038	....	......
2/25	.....	.....	.....	.....	.....	.....	.....	.....	463	1,038	....	......
2/27	.....	.....	.....	.....	461.4	1,056	.....	.....	.....	.....	....	......
3/6	.....	.....	.....	.....	268.8	703	.....	.....	.....	.....	....	......
3/13	.....	.....	579.9	1,338	.....	.....	.....	.....	.....	.....	....	......
3/13	.....	.....	386.6	912	.....	.....	.....	.....	.....	.....	....	......
Totals of 7 replacements—November 1-March 15											2,806.8	6,584
Totals of the 10 originals and 12 replacements—June 20-March 15											5,298.4	13,842
7/21	542.3	1,266	.....	.....	.....	.....	.....	.....	.....	.....	....	......
9/23	324.3	813	.....	.....	.....	.....	.....	.....	.....	.....	....	......
10/23	.....	.....	.....	.....	.....	.....	325.8	816	.....	.....	....	......
12/9	.....	.....	.....	.....	.....	.....	215.4	471	.....	.....	....	......
2/25	.....	.....	.....	.....	.....	.....	.....	.....	32.3	69	....	......
2/25	.....	.....	.....	.....	.....	.....	.....	.....	32.3	69	....	......
2/27	.....	.....	.....	.....	43.9	151	.....	.....	.....	.....	....	......
3/6	.....	.....	.....	.....	22.7	95	.....	.....	.....	.....	....	......
3/13	.....	.....	0	0	.....	.....	.....	.....	.....	.....	....	......
3/13	.....	.....	0	0	.....	.....	.....	.....	.....	.....	....	......
Totals of 8 still usable replacements as of March 15											1,539.0	3,750
Grand total of the 30 tires used as of March 15											6,837.4	17,592

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